DOI: 10.24996/ijs.2025.66.3.10

ISSN: 0067-2904

Geomorphological and Environmental Characteristics of the Al-Mashab and Al-Salal Marshes, Southern Iraq

Zainab D. Hassan
Department of geology,College of Science, University of Baghdad , Baghdad, Iraq

Received: 22/10/2023 Accepted: 25/3/2024 Published: 30/3/2025

Abstract

Marshes are a geomorphological phenomenon found in southern and southeastern Iraq. The study area is part of these wetlands located in an arid region, which play a significant role in softening the region's climate as well as its economic and tourist importance. The objective is to assess the environmental geomorphology of the marshes west of Basra, specifically the marshes of Al-Mashab and Al-Salal. Soil and water samples were collected through fieldwork, and the physical, and chemical of the major elements were conducted.

The study area is polluted with high concentrations of major elements in both water and soil compared to the Iraqi and global standards. The north part of the study area shows a high EC value of 17 s/cm, TDS3090 mg/l, chloride 1813 mg/l, sulfate 800mg/l and calcium 350mg/l as well as high concentrations of sodium (42000ppm, calcium 35000ppm, sulfate 11280ppm, chloride 24802ppm). The digital processing and analysis results of satellite visualizations were adopted in the Erdas V.2014 and GIS software V10.4 by applying the equations of the NDWI water guide and the normalized difference vegetation index (NDVI) and designing a mathematical model in the GIS program to detect the change during the study period (1973-2016). The increase in vegetation cover in 1973 shows that water was the largest area during the studied period by 5 km^2 in 2016. The area of the intersecting area that has not been subjected to change for water is 5.5 km^2 and for vegetation cover is 8.7 km^2.

Keywords: Iraq Marshlands, Environmental Assessment, Wetlands.

الخصائص الجيومورفولوجية و البيئية لأهوار المسحب والصلال جنوب العراق

زينب ضمد حسن
قسم علم الارض ,كلية العلوم ,جامعة بغداد, بغداد, العراق

الخلاصه

تعد الاهوار ظاهرة جيومورفولوجية تسود الاجزاء الجنوبية والجنوبية الشرقية من العراق، وتمثل منطقة الدراسة جزءاً من هذه الاراضي الرطبة التي تقع في اقليم جاف وشبه جاف، ولها دور كبير في تلطيف مناخ المنطقة فضلاًعن اهميتها الاقتصادية والسياحية. تهدف الدراسة الى تقويم جيومورفولوجي بيئي لاهوار غرب البصرة المتمثلة بأهوار المسحب والصلال، باجراء مسح ميداني لجمع عينات التربة والمياه، واجراء التحاليل المختبرية، الفيزيائية والكيميائية للعناصر الاساسية. توصلت النتائج الى تلوث منطقة الدراسة من خلال ارتفاع تراكيز العناصر الاساسية للمياه والتربة مقارنة بالمحددات العراقية والعالمية، شمال منطقة الدراسة بارتفاع

Email: zainab.hassan@sc.uobaghdad.edu.iq

قيمة Ec اذ بلغت (17 s/cm) و TDS (3090 mg/l)، والكلورايد (1813mg/l) والكبريتات (800mg/l) والكالسيوم (350mg/l) . فضلا عن ارتفاع تراكيز العناصر في التربة مثل الصوديوم (42000ppm)، الكالسيوم (35000ppm)، الكبريتات (11280ppm)، والكلورايد (24802ppm).وتم اعتماد نتائج المعالجة والتحليل الرقمي للمرئيات الفضائية في برنامجي برنامجي Erdas V.2014 و GIS.V10.4 بتطبيق معادلات دليل المياه NDWI ودليل النبات الخضري NDVI وتصميم موديل رياضي في برنامج نظم المعلومات الجغرافية لكشف التغير الحاصل خلال مدة الدراسة1973-2016.إذ تبين الزيادة في مساحة الغطاء النباتي في السنة المرجعية التي تمثل عام 1973 اما المياه فكانت اكثر مساحة خلال مدة الدراسة بفارق 5كم^2 في عام 2016. اما مساحة المنطقة المتقاطعة التي لم تتعرض لتغير بالنسبة للمياه5.5كم2 وللغطاء النباتي8.7كم^2.

1. Introduction

The marshes are distinguished natural reserves, which have tourism, economic and environmental importance, with an important impact in mitigating the climate of the southern and central regions of Iraq. It represents a wet swampy area that suffers from poor drainage and consists of flat and lowlands [1]. It is a source of raw materials for cane and papyrus, in the paper industry, and the provision of fodder. It is also a source of food by providing fisheries, in addition to its historical importance The oldest civilizations were based on it, represented by the Sumerian civilization (275-3000 BC). The Al-Mashab Marsh and Al-Salal Marsh represent the lower reaches of the Hammar Marsh. The marshes were subjected to many negative human practices that prevented the sustainability of their natural entity. In addition to the lack of water resources due to the construction of dams and reservoirs on the Tigris and Euphrates rivers by the Turkish side, and the diversion of the watercourses of the tributaries that flow into the eastern marshes by the Iranian side into its lands, such as the Karun and Karkheh rivers, which were hindering the progress of the salty water of the Shatt al-Arab waters towards the lands agriculture, especially the Fao area, in addition to the loss of economic wealth such as livestock and fish, due to high water salinity, the decay of historical handicrafts, the manufacture of boats and houses, the paper industry and other industries that depend on reeds and papyrus, and thus the migration of most of the population of the region. The natural concentration of chemical compounds is characterized as a base and background for determining the proportion of human sources [2, 3, 4]

Marshes provide a unique opportunity to assess the chronic inputs of land-derived pollutants to aquatic ecosystems. Contaminants that accumulate on the ground and are eroded by rain result in runoff that carries the chemical footprint of the land it crosses. Since residential and undeveloped land uses are associated with different levels of accumulation of Principal Organic Hazardous Constituent (POHCs), adjacent wetland sediments must reflect differences in the concentration of POHCs as they clear molecules from runoff [5, 6].

Abed Al-Razaq et al. studied the monitoring and evaluation of the environmental changes that had happened in the main features (water, vegetation, and soil) of the Al-Hammar Marsh region in Iraq using the adaptive classification method [7].

Al-Dabbas et al. studied the hydrochemical evaluation of the Main Drain and Hor Dalmaj, where they concluded that the water of both Dalmaj and the main drain water is unsuitable for human drinking because have exceeded permissible limits and they are acceptable grade for livestock and poultry [8]. Al-Dabbas et al. studied the hydrochemical assessment of the feed water In the western part of Huwaiza Marsh, Where they suggested that the marsh water is unsuitable for human drinking because most of the variable's rates exceeded the permissible limits and the acceptable grade for livestock and poultry [9].

The marshes of Al-Mashab and Al-Salal are among the Iraqi marshes that are of great importance, so it is necessary to reveal the problems that impede the restoration of their natural entity and the transformation of their investment into tourism and economy. The study aims to an environmental geomorphological assessment of the reality of the Al-Mashab and Al-Salal Marshes, through the analysis of the basic elements of soil and water. In addition to analysis of satellite images for comparison during the study period.

1.1 Geography and Geology of the study area

The Al-Mashab and Al-Salal Marshes are bounded by longitude (47° 35`E 47° 45`E) and two latitudes (30° 33`N 30° 35`N) to the northwest of Basra Governorate in Iraq. They are located to the east of Al-Hammar Marsh, specifically within the open and shallow waters that are between the Al-Mushab and Al-Salal rivers near Karmat Ali and start from Al-Mushab Bridge towards the west to the Al-Hammar Marsh. It is fed by several tributaries, the most important of which is Karmat Ali, which branches out from the Shatt Al-Arab, the Mansouriya River, and the Al-Haffar River [10]. Al-Hammar towards Al-Nasiriyah, the width of the intake does not exceed 100 m, while Al-Salal has a width of approximately 300 m, and both flow into the vineyard of Ali. As for the water movement in this region, it depends on the tidal movement that occurs from the Arabian Gulf twice a day (Figure 1).

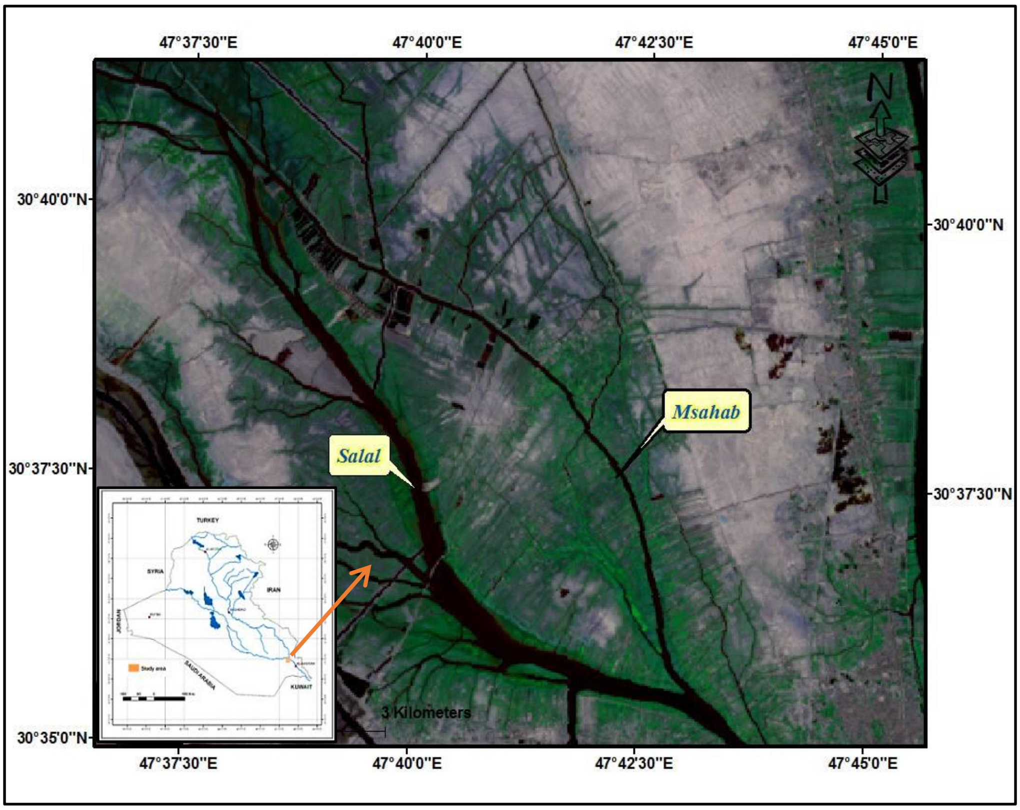

Figure 1: Landsat satellite images showing the location of the study area in Iraq

The geology of the study area represents marine sediments, estuaries, river sediments, marsh sediments, deep, shallow and saline lakes, sediments of sabkhas, and wind sediments. The climate of the study area is located within the continental-desert climate according to the Köppen climate classification, which includes the sedimentary plain and the desert, which is characterised by high values of temperatures, lack of rain, and a large daily temperature range, in which hot, moist southern winds prevail [11]. According to the climatic rates of the general authority for meteorology and seismic monitoring during the study period, it is shown the annual average temperature, 26.1 ̊C, and the month of July represents the highest rate for it, reaching 37.4 ̊C. The annual amount of evaporation at the Basra station was estimated at 3220 mm. The annual rainfall is 134.4 mm, the relative humidity percentage of the annual rate for the Basrah station itself is 50.9%, and the average wind speed is 5.3 m/s and 7.5 m/s in July. for each of the Basra and Nasiriyah stations, respectively [12].

2. Methods and materials

2.1 Soils

The soil of the study area is part of the sedimentary plain soil, and it is a transferred calcareous clay soil with a lime content of 12%, It is newly formed, transported and deposited from the floods of the Tigris and Euphrates, and it was affected by wind erosion [13]. The soil samples were collected in November 2015, and selected based on differences in texture, type of sediment, and color, which are characteristics that can be distinguished in the field, and separate places with cross sections. Excavations were made in dry areas within the soil of the Al-Mashab and Al-Salal marshes, with a depth of 5-15 cm. They were placed in plastic bags and transferred to the central environmental laboratory of the Ministry of Environment, to conduct standard chemical analysis. After going through the following processes before using it for analysis purposes, including drying, crushing, removing impurities and gravel, then sieving and removing the remaining part on the sieve.

2.2 Water

As for water samples, they used plastic bottles with a capacity of 1.5 liters. These bottles were washed with distilled water and diluted acid, and then with distilled water. It was taken from cross sections, and one sample was taken from the middle of each section from the middle of the water depth, considering the pollution sites and the speed of water flow [14]. It was transferred to the central environmental laboratory of the Ministry of Environment, to conduct standard chemical analysis on it. The coordinates of each sample were determined by the GPS device (Figure 2)

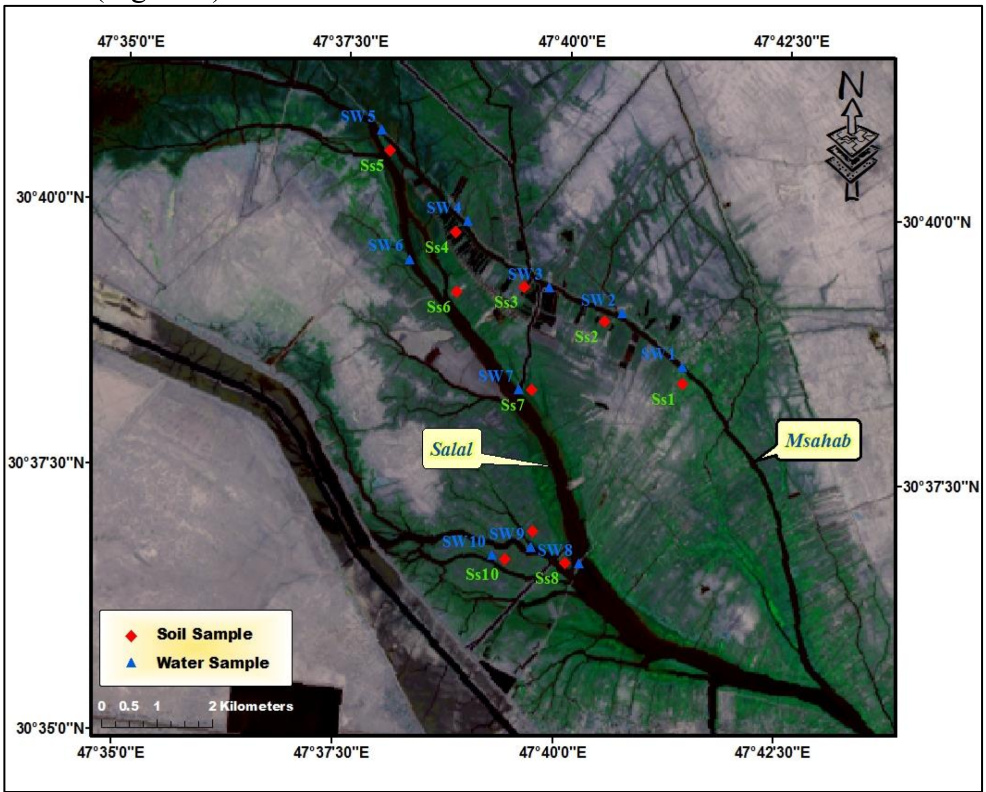

Figure 2: Locations of soil and water samples in the marshes of Al-Mashab and Al-Salal.

2.3 Data and Software

Landsat satellite imagery was ordered to reach back as far as possible as well as to cover periods at regular intervals. The achieved time series encompasses four times (1973, 1990, 2000,2016), the Erdas V.2014 program was used to analyze raw satellite images (Raw Image) for the summer season of MSS satellites for the year 1973, ETM+ Landsat-7 for the year 1990 and 2000, Landsat-8 LDCM for the year 2016[15]. Vegetation index Dense vegetation value is approached using NDVI (Normalized Difference Vegetation Index). NDVI values were calculated on composite images. NDVI use band 3 (Red) and 4 (Near Infrared) for Landsat 7, and band 4 (Red) comes with band 5 (Near Infrared) for Landsat 8. The evidence was used to indicate the areas of vegetation that exist in the western Basra region During the study period such as the Normalized Difference Water Index (NDWI) to accurately determine the existing water sources to clarify the exposed water area. Normalized Difference Vegetation Index (NDVI). Remote sensing techniques provide important capabilities to map surface water features and monitor the dynamics of surface water. Water body information is very important for urban planning and environmental improvement. The NDWI is a new method that has been developed primarily to delineate open water features and to enhance their presence in remotely sensed digital imagery while simultaneously eliminating soil and terrestrial vegetation features [16].

The index takes advantage of the situation in which features with higher near-infrared reflectance and lower red-light reflectance (e.g., terrestrial vegetation) are enhanced, while those with low red-light reflectance and very low NIR reflectance (e.g., water) are suppressed or even eliminated. The index can be derived from data supplied from ground-based, airborne, or satellite platforms that have sensors recording reflected red light and near-infrared radiation (NIR-RED) / (NIR + RED) The results of the index can range from -1 to +1. Vegetated surfaces tend to have positive values, bare soil may be near zero, and open-water features have negative values.[17] NDVI also had been used broadly to analyse the spatiotemporal changes in vegetation coverage. The vegetation index calculates the balance between the energy obtained and emitted by earth objects using the Red and NIR bands [18].

(NDVI) is an index of plant greenness or photosynthetic activity. It is a commonly used and easily calculated satellite image-based proxy for vegetation productivity. [19],[20]
The NDVI algorithm is computed by subtracting the red reflectance values from the near-infrared and dividing it by the sum of near-infrared and red bands. The function used such as follows,

NDVI) as" Eq. 1" [21]

$$\mathrm{NDVI} = (\mathrm{NIR} - \mathrm{Red}) / (\mathrm{NIR} + \mathrm{Red}) \tag{1}$$

Whereas NIR represents the spectral reflectance in the near-infrared band while RED represents the red band. NDVI values range from -1 to 1. A very low value of NDVI corresponds to barren areas of rock, sand, snow, cloud etc.) Moderate values represent shrubs and grassland while high value indicates temperate and tropical rainforests. Bare soil is represented with NDVI values which are closest to 0 and water bodies are represented with negative NDVI values [22]

Numerical analysis and calculation of areas were performed for the results of applying equations in the Arc GIS V.10.4 program through a set of analytical tools, the most important of which is the classification process by dividing the visual into categories, each category representing a certain percentage depending on the resulting reflectivity values and then perform a process (Raster Calculator) from the Spatial Analysis Tool, after selecting a suitable threshold limit to isolate the required reflectivity values easily through simulation in a mathematical formula with the program by selecting a specific category without other classified categories. Then deal with it more flexibly by converting it into a polygon using another feature of the Spatial Analysis Tool represented by (Raster to Polygon) to convert it from a point layer to a layer of vector data.

After converting the cellular data (Raster Data) into a polygon format, then converting the resulting spatial values into a numerical format or a symbolic expression by converting it into a category by giving it a unique value of zero-one utilizing the Grid Cod (0-1) command, then we sort it From querying by specific property is Selection by Attribute for values equal to 1 only to exclude unwanted values less than 1.

Then it is converted into a shape file to make it easier to deal with in area calculation and change detection operations. The format and application of the area calculation process was using the Calculator Area command from the Spatial Analysis Tool, and then Dissolve to merge the dispersed areas. After applying Statistical equations and calculation of areas for the governorates included within the study area and the satellite landscape of the marshes of western Basra and the marginal areas.

2. Results

Table 1: Concentrations of some major elements in the soil samples of Al-Mashab and Al-Salal Marshes in units (ppm).

S.Nu.	X	Y	Na	Ca	Mg	SO4	Cl
Msahab1	**E 047.697**	**N 30.642**	**17000**	**5000**	**1019**	**6744**	**24802**
Msahab2	**E 47 .674**	**N 30.649**	**8000**	**25500**	**698**	**24**	**8205**
Msahab3	**E 047.659**	**N 30.654**	**13000**	**4000**	**1128**	**5839**	**6829**
Msahab4	**E 047.646**	**N 30.663**	**10500**	**27000**	**689**	**7804**	**1771**
Msahab5	**E 047.633**	**N 30.675**	**10000**	**8000**	**1045**	**11280**	**13625**
Salal 6	**E 047.646**	**N 30.653**	**15000**	**19500**	**933**	**3915**	**13594**
Salal 7	**E 047.661**	**N 30.638**	**12000**	**32000**	**633**	**1794**	**7729**
Salal 8	**E 047.669**	**N 30.611**	**42000**	**35000**	**658.7**	**5271**	**36831**
Salal 9	**E 47.662**	**N30.616**	**13000**	**7000**	**1091**	**4979**	**9409**
Salal 10	**E 47.611**	**N 30.611**	**6500**	**6500**	**1155**	**2148**	**9040**
Limits according to[23]			**10000**	**-**	**>2500**	**>2500**	**>5000**
Limits according to[24]			**-**	**>2500**	**-**	**-**	**-**

Table 2: The results of the concentrations of physical parameters and major elements in the water samples of the Al-Mashab and Al-Salal Marshes.

S.Nu.	X	Y	Temp. Cº	EC s/cm	TDS mg/l	PH mg/l	Na mg/l	Ca mg/l	K mg/l	Mg mg/l	Cl mg/l	SO_4 mg/l	NO_3 mg/l
Msahab 1	E 047.6894	N 30.6426	17.8	12.9	2350	8	500	240	9.5	127	1080	400	2.7
Msahab 2	47 .6777 E	N 30.6507	17	5	2380	7.4	490	240	9.8	128	1272	800	1.6
Msahab 3	E 047.6638	N 30.6545	16.7	13	2430	7.9	570	280	10	128	1301	510	2.4
Msahab 4	E 047.6595	N 30.6572	17	13	2440	7.4	590	282	10	128	1333	580	2.8
Msahab 5	E 047.6313	N 30.6785	19	13.4	2480	7.9	565	305	10	124	1415	430	2
Salal 6	E 047.6372	N 30.6583	17	17	3090	7.5	885	315	16	132	1813	590	2.9
Salal 7	E 047.6586	N 30.6383	17.7	14	2410	7.4	650	280	11	94	1323	360	2.5
Salal 8	E 047.6708	N 30.6113	17	13	2340	7.6	545	305	9.6	94	1232	590	10
Salal 9	E 47.6617	N30.6136	17	13	2350	7.6	635	280	10	112	1537	590	2.8
Salal 10	E 47.6544	N 30.6122	17	14	2450	7.5	670	350	11	112	1446	520	3.6
Iraqi Limits			35<	4	1500	6-9.5	200	200	15-20	50	200	200 <	50 <

The time factor is important in detecting changes, so satellite visuals must be taken during the same season and by the same satellite to produce logical and more accurate results depending on the base year.

The results of digital processing and analysis of the satellite image were adopted in designing a mathematical model in the geographic information systems program to detect the change that occurred during the study period. One of the spatial analytical commands available in the program is represented by (the Spatial Analysis Tool), which provides the possibility through the command (Erase Overly Model), which is useful in distinguishing the points of difference in terrestrial phenomena, by finding the difference in the spectral reflectivity values of the pixels of each phenomenon, after Converting the phenomenon into a vector data (Vector Layer), then it is dealt with as a shape file. The change was detected for each equation of vegetation and water, then the area of the resulting change was calculated, areas of increase and decrease were indicated, and the intersection areas that were not subjected to change were identified and mapped. The results of the analysis were as Table 3 and Figures 3, 4, 5, 6, 7, 8, 9, 10 and 11:

Table 3: The visualized results for major ecological compounds in the studied area**.**

Year	Clear water KM^2	Change Detection KM^2	Vegetation KM^2	Change Detection KM^2
1973	9	RFC.	42.6	RFC.
1990	7.69	1.3	22.4	20.2
2000	7.49	1.5	7.7	34.9
2016	14	5	15	27.6

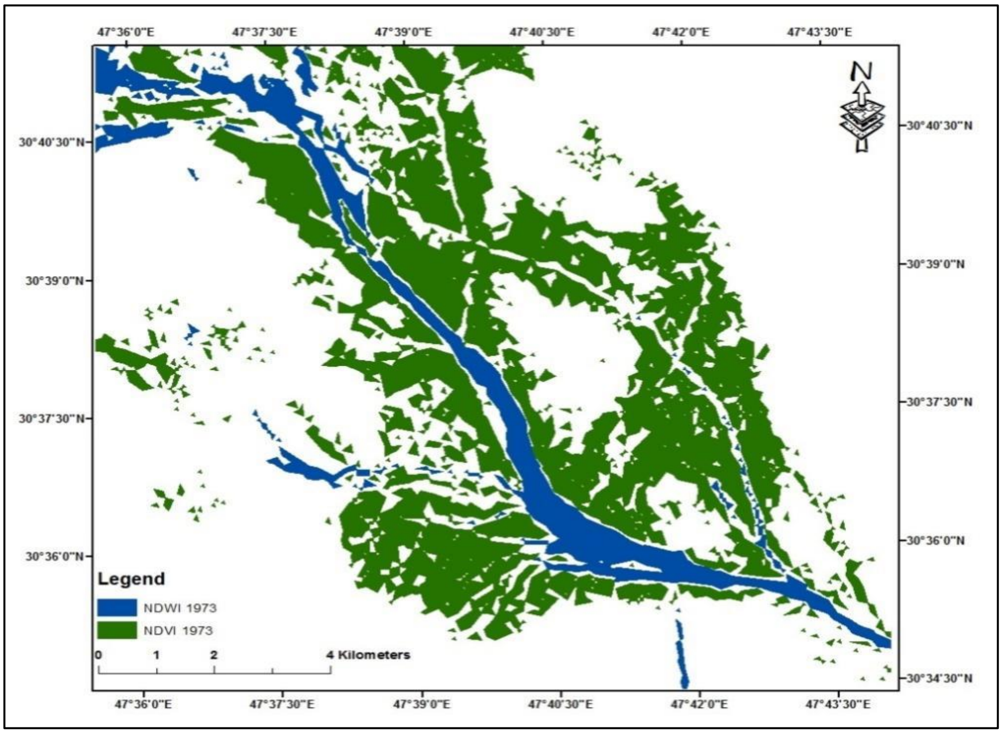

Figure 3: The map shows Clear Water and Vegetation year 1973.

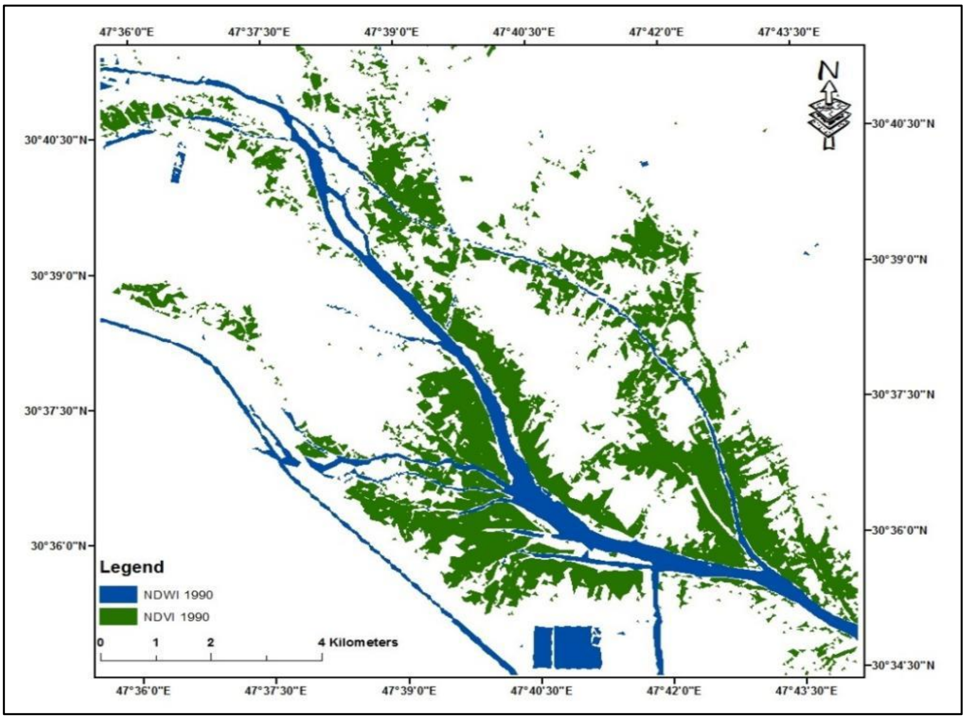

Figure 4: The map shows Clear Water and Vegetation year 1990

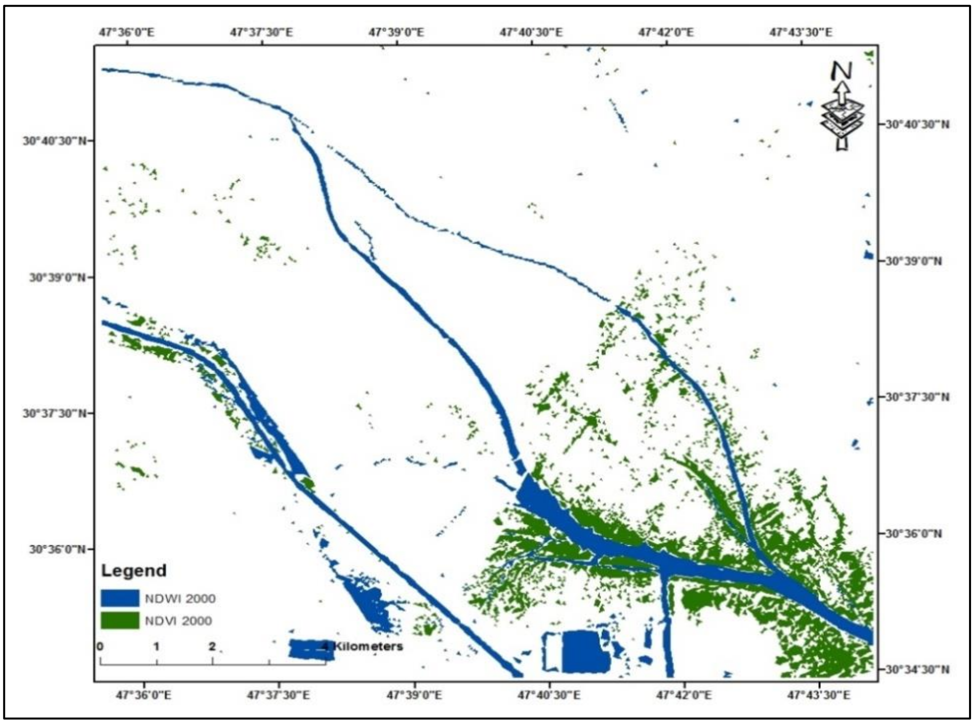

Figure 5: The map shows Clear Water and Vegetation year 2000

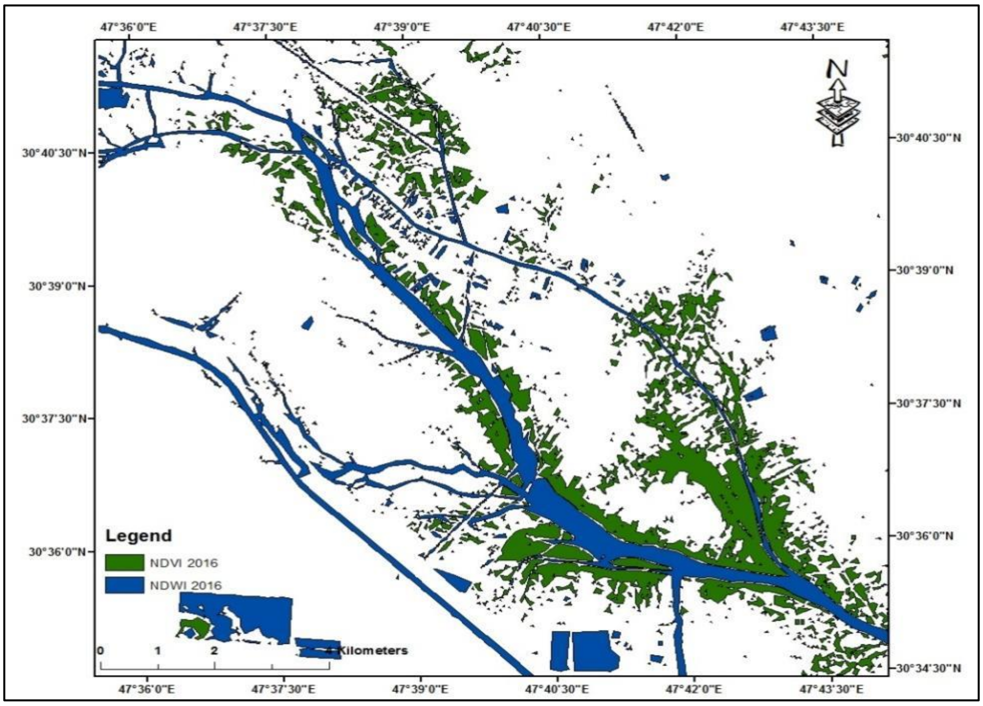

Figure 6: The map shows Clear Water and Vegetation year 2016

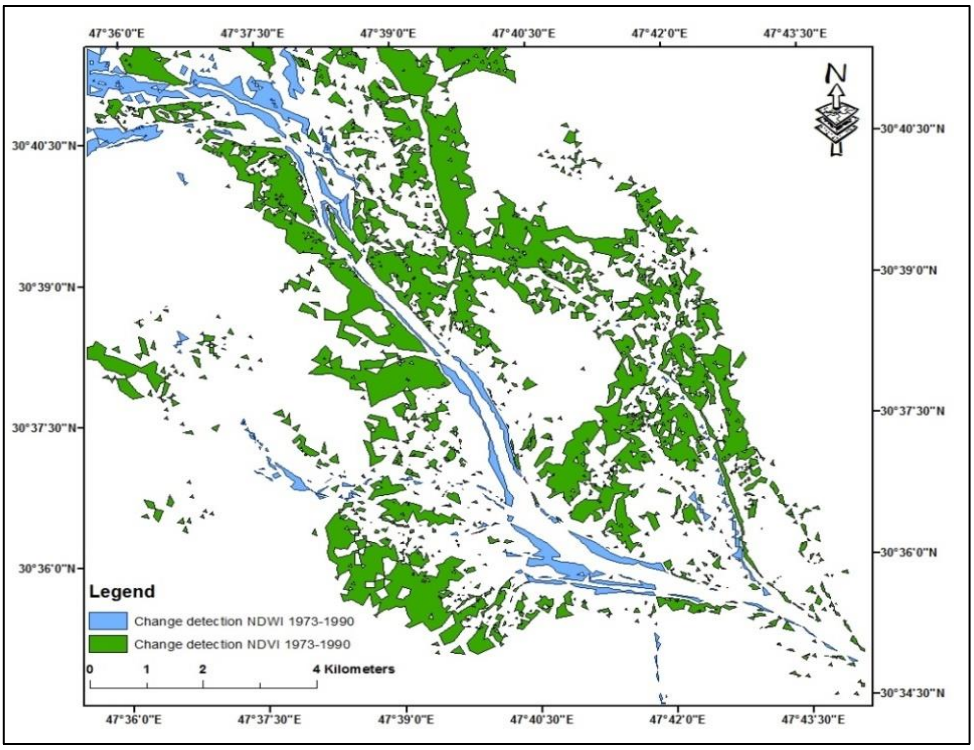

Figure 7: Change detection Clear Water and Vegetation between 1973-1990

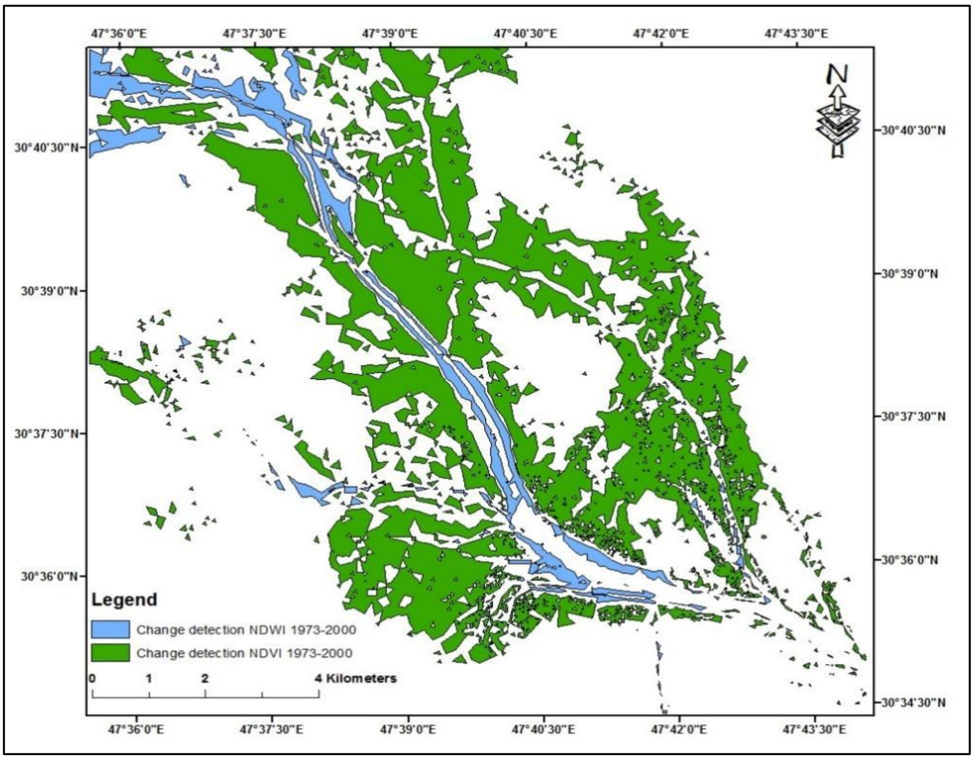

Figure 8: Change detection Clear Water and Vegetation between 1973-2000**.**

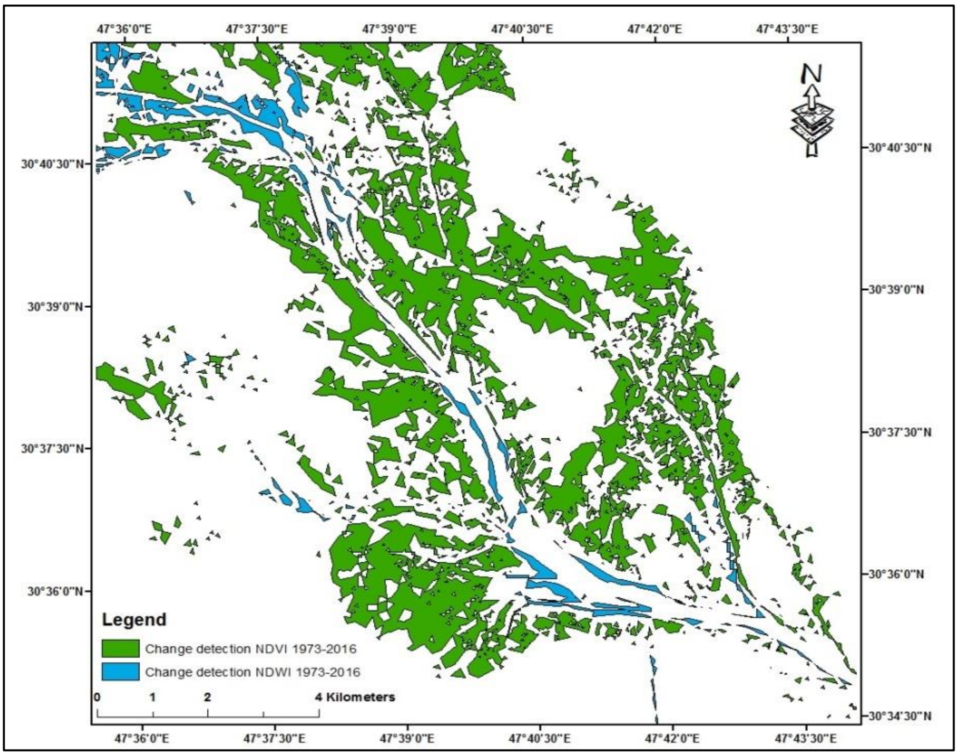

Figure 9: Change detection Clear Water and Vegetation between 1973-2016

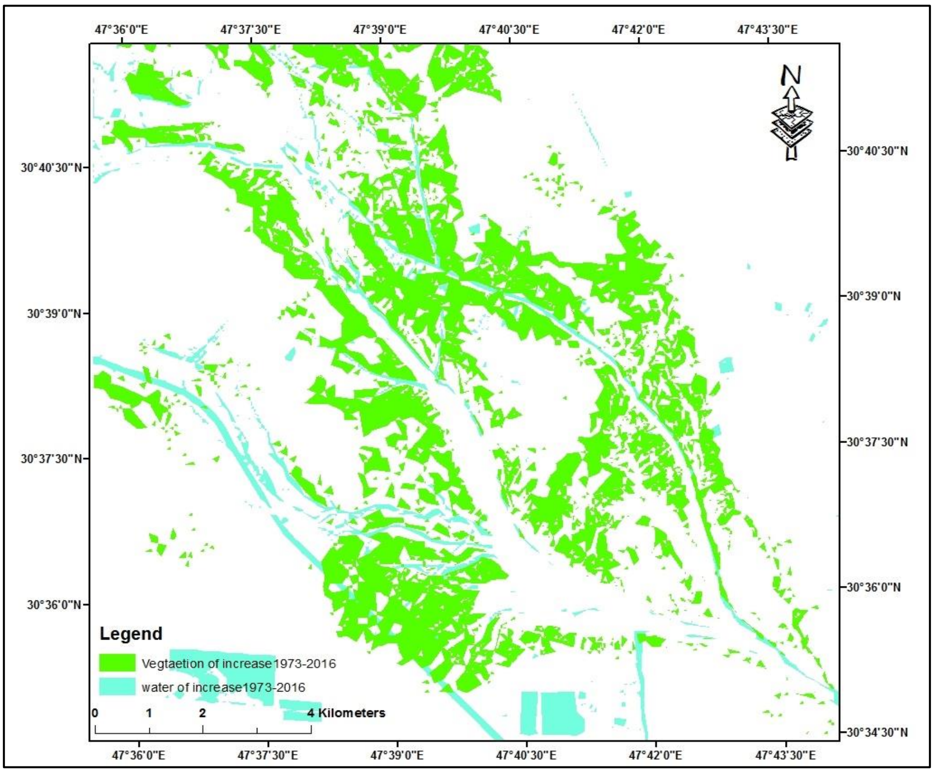

Figure 10: Change detection Clear Water and Vegetation of increase 1973-2016

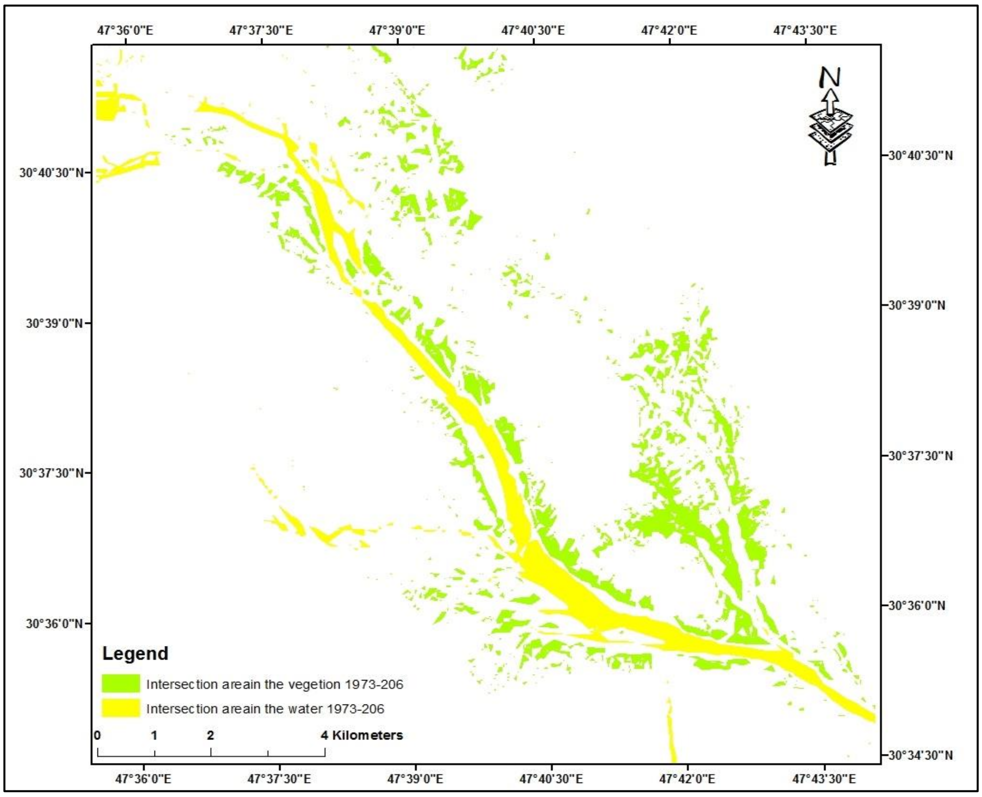

Figure 11: Intersection area in the Water and Vegetation 1973-2016

5. Conclusions

The most important conclusions found by this study are:

1. The soil and waters of the marshes were exposed to pollution, salinity concentrations, and the deposition of pesticides and agricultural fertilizers, in addition to the lack of natural flow of water due to the earthen barriers used for drying, which cooperated with poor drainage, and worked to concentrate the pollutants and not dispose of them in the sea water, on the other hand This contributed to the loss of suitable lands and their transformation into sabkhas, which means that agricultural systems were destroyed by converting them into sabkhas.

2. The results of laboratory analyses showed that the water of the Al-Mashab and Al-Salal marshes acquired a basic character, and the electrical conductivity (EC) and total dissolved substances (TDS) values increased, due to the low discharge rates of the Tigris and Euphrates rivers, which lead to high concentrations of dissolved salts and their concentration in the water, as it carries quantities of salts and sediment to these low areas, and thus the high values of EC and TDS. The highest value of Ec reached 17s/cm and TDS 3090 mg/l in the northern part of Al-Salal water.

3. The major elements are characterized by high concentrations in the Al-Mashab and Al-Salal marshes, as they exceeded the chloride concentrations. Concentrations of sulfates are also high in the marshlands, compared to the waters of the Tigris and Euphrates rivers, due to the wastes carried by the two rivers, the highest concentration for chloride reaches1813 mg/l and sulfate 800 mg/l.

4. The study showed an increase in calcium ion concentrations (Ca) in the marsh waters, Its concentration in salal water reached 350mg/l.The results of the study showed that there is an increase in the concentration of sodium ions in the salal marsh waters at 885 mg/l.

5. Some soil samples of the Al-Mashab and Al-Salal Marshes showed high concentrations. The highest value for sodium was 42000 ppm and for calcium was 35000 ppm in Al-Salal soil, in addition to the high concentration of chlorine, reaching 24802 ppm in Al-Mashab soil.
6. The year 1973 represents the balance of the ecosystem, which was represented by the density of vegetation cover and abundance of water, with a water area of 9 km^2 and a vegetation cover area of 42.6 km^2. The marshes began to gradually decline due to high temperatures, lack of airport and lack of water revenues, as the water area reached 7.69 km^2, while the vegetation cover was 22.4 km^2. In 2000, open water constituted an area of 7.49 km^2, and the vegetation cover was 7.7 km^2. For 2016, the water area constituted 14 km^2 and vegetation covered 15 km^2.
7. Using 1973 as the reference year of the study, the change between 1973 and 1990 was revealed with a significant change of 20.2 km^2 in vegetation cover and a decrease in water change of 1.3 km^2. The amount of change between 1973 and 2000 in water was 1.5 km^2 and 34.9 km^2 in vegetation. The detection of the change in the water area for the year 2016 amounted to 5 km^2 and a change in the vegetation cover for the same year was 27.6 km^2. From the application of the analysis tools, it was found that there was an increase in the area of vegetation cover in the reference year representing 1973, while water was the most area during the study period by a difference of 5 km^2 in 2016. The area of the intersecting area, which has not been subjected to change, is 5.5 km^2 and vegetation cover is 8.7 km^2.

References

[1] R. Farhat, H. Abu Al-Enein, *Philips Publications: Geography Dictionary, 1st edition, Kuwait Foundation for the Advancement of Sciences, Kuwait,* p.142
[2] S.G. David Thomas, *The Dictionary of Physical Geography, Fourth Edition, by John Wiley & Sons Ltd,* 2016, p. 614.
[3] J.S. Latimer, J. Zheng, Sources, *transport and fate of PAH sin the marine environment, in: P.E.T. Douben (Ed.), PAHs: An Ecotoxicological Perspective, Wiley, UK*, 2003, p. 9-33.
[4] J.F. Payne, A. Mathieu, T.K. *Collier, Ecotoxicological studies focusing on marine and freshwater fish, in: P.E.T. Douben (Ed.), PAHs: An Ecotoxicological Perspective, Wiley, UK*, 2003, p.191-224.
[5] A.C. Menzie et al., “Urban and suburban storm water runoff as a source of PAHs (polycyclic aromatic hydrocarbons) to Massachusetts estuarine and coastal environment,” *Estuaries*, v. 25, pp. 165-176, 2002.
[6] US EPA, “Introduction to nonpoint source pollution and wetland mitigation, in: Created and Natural Wetlands for Controlling Nonpoint Source Pollution”, *Smoley, Boca Raton*, pp. 7-41, 1993.
[7] B. Abed- Al-Razaq, S. K.l Shnain, and S. J. Abd Al-Hamza, “Monitoring of environmental variations of marshes in Iraq using Adaptive classification method,” *Iraqi Journal of Science*, vol 56, no.3B, pp: 2401-241, 2015.
[8] M. A. Al-Dabbas, W. M. Jassim and W. H. Kadhim,” Hydrochemical Evaluation Of The Main Drain And Hor Dalmaj, Central Iraq,” *Iraqi Geological Journal*, vol.39 – 49, no.1, pp 36-48, 2016a.
[9] M. A. Al-Dabbas, A.M. Al-Obaidy and T. K. Abed, “Hydrochemical Assessment Of The Feed Water In The Western Part Of Huwaiza Marsh, Maissan Governorate”, South Of Iraq. *Iraqi Geological Journal*, vol.39 – 49, no.2, pp. 46-60, 2016b.
[10] P. H. Witt, R. Fosnight, G. Singh, A. Pietro, D. D. "The Mesopotamian Marshlands: Demise of an Ecosystem", UNEP Study, 2001.
[11] M. A. Wali,” Geographical Factors and their Impact on the Spread of Salts in Mesopotamian Plain”, *Journal of the Iraqi Geographical Society*, v17, pp. 121, 1986.
[12] Monthly and annual rates of climatic elements of Nasiriyah and Basra stations for the duration. Source: Ministry of Transportation and Communications, General Authority for Meteorology and Seismic Monitoring, Climate Section, unpublished data, 2016.

[13] C. Hested, , *The Natural Foundations of the Geography of Iraq, : translated by: Jassim Muhammad Al-Khalaf, Ministry of Education / Dar Al-Mualim Al-Alia - 1st Edition - Arabic Press, Baghdad*, p.117, 1948.

[14] S. A. Abbadi, *Practical Engineering of the Environment (Water Tests): Dar Al-Hikma for Printing and Publishing, Mosul*, 1990, pp. 5.

[15] USGS science for a chaging world: Landsat 8 by Landsat Mission. Available : https://www.usgs.gov/landsat-missions/landsat-8

[16] P. Pallavi, Shaik Salam,"Online Command Area Water Resource Management System," *APTIKOM Journal on Computer Science and Information Technologies*, v. 5, no. 2, pp. 209-213, 2020.

[17] S. K. Mc Feeters, "The use of the Normalized Difference Water Index (NDWI) in the delineation of open water features," *International Journal of Remote Sensing*, U.S.A Published online: 27, 2007.

[18] H. Hashim, Z. Abd Latif, N. A. Adnan, "Urban Vegetation Classification With Ndvi Threshold Value Method With Very High Resolution (Vhr) Pleiades Imagery", *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, v XLII-4/W16,*in proceeding of the 6th International Conference on Geomatics and Geospatial Technology (GGT 2019)*, Malaysia, 2019.

[19] T.M. Scanlon, J. Albertson, K. Caylor, and C. Williams, "Determining land surface fractional cover from NDVI and rainfall time series for a savanna ecosystem", *Remote Sens Environ*. v 82, pp. 376–388, 2002.

[20] M.L. Kunkel, A.N. Flores, T.J. Smith and J.P. McNamara; S.G. Benner, "A simplified approach for estimating soil carbon and nitrogen stocks in semi-arid complex terrain", *Geoderma*, v.165, pp.1–11, 2011.

[21] C.J. Tucker, "Red and photographic infrared linear combinations for monitoring vegetation", *Remote Sens Environ*, v.10 (1), pp. 23-32, 1979.

[22] A. Karaburun, "Estimation of C factor for soil erosion modeling using NDVI in Buyukcekmece watershed," *Ozean journal of applied sciences*, v. 3, pp.77-85, 2010.

[23] S. K. Jain and et al., *Delineation of Flood-Prone Areas Using Remote Sensing Techniques, Water Resources Management 19: 333–347. Remote Sensing Application Division, National Institute of Hydrology, Bhawan Roorkee Jalvigyan 247 667, India*, 2005, P.341

[24] L. Noam, *Fundamentals of Remote Sensing, Italy: IMO - International Maritime Academy, Trieste*, 1999.